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SLIDING WEAR BEHAVIOR OF DLC UNDER LUBRICATED CONDITIONS AT ELEVATED TEMPERATURES

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KEYWORDS

Wear Volume; Aluminum oxide; Silicon Nitride; Lubricant; Tribo Oxidation.

ABSTRACT

The influence of temperature and counter body material on the tribological properties of a-C:H coatings deposited on Cronidur 30 steel has been investigated in a lubricated ball on disk contact situation with an oil temperature up to 250°C. The results show, that the wear volumes of the system increase exponentially with increasing temperature. Two different wear mechanisms seem to have a major influence: First, the abrasive action due to materials hardness and second, the tribo-oxidation when silicon nitride is counter material. The counter bodies were made of aluminum oxide and silicon nitride with a diameter of 10 mm. The DLC layer is an a-C:H layer (KYB Type A from KYB, Sagamihara, Japan) with a chromium intermediate bond layer of about 50 nm deposited on steel Cronidur 30-(X 30 CrMoN 151, annealing temperature of about 480°C). The tribological tests were carried out with SRV 3 tribometer (Optimol Instr., Munich, Germany) in a ball on disk configuration and a normal load of 10 N.

At room temperature the wear resistance of the a-C:H coating against α-alumina counter body is about 2.5 times higher than against silicon nitride. With increasing temperatures, the ongoing softening of the DLC layer leads to a stronger increasing wear volume with α-alumina counter body since its hardness remains high and tribo-oxidation is not existent. In the case of silicon nitride as counter material, the wear volume is initially higher due to the underlying tribo-oxidation on silicon nitride counter body. One possible oxidation reaction is the following:

$$Si_3N_4 + 5O_2 \longrightarrow 3SiO_2 + 4NO$$

With increasing temperature, however, the wear volume increases, too, but not as sharply with temperature as in the case of α-alumina. This may be explained by, first, the lower hardness of silicon nitride (less abrasive) and second, by the increasing content of silica as a product of the tribo-oxidation process and its influence on wear as a wear modifying constituent of the lubricant [1]. This may also explain the observed difference in the coefficient of friction. At all temperatures the friction coefficient is significantly lower with α-alumina as counter material. Generally, these findings correlate well with the results of an earlier investigation on ta-C coatings under dry sliding conditions [2].

REFERENCES

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